IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors:	Rajiv Jain et al.		
Assignee:	QuickLogic Corporation		
Title:	Method of Programming an Antifuse		
Serial No.:	09/887,834	Filing Date:	June 22, 2001
Examiner:	Terry Cunningham	Group Art Unit:	2816
Docket No.:	QKL9351 US	Confirmation No.:	7855

Santa Clara, California
March 23, 2004

Mail Stop Appeal Brief - Patents
Commissioner For Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPELLANT'S REPLY BRIEF

Dear Sir:

This Reply Brief is filed on behalf of the Appellant in response to the Examiner's Answer dated January 27, 2004, in the above-referenced case. Appellant has attached hereto as an Appendix the claims that are involved in this appeal, taking into account the Examiner's change to the status of the claims.

Appellant's have requested oral hearing in this matter in a separate paper which is filed herewith.

Appellant suggest that perhaps the Examiner's rejections in this case are based on an apparently fundamental misunderstanding of the law of anticipation. The Examiner stated at page 6, third paragraph, that "[t]he requirement of 35 U.S.C. §102 is that one skilled in the art would 'anticipate' the invention." Appellant is not aware of any such requirement for §102. Moreover, the Examiner's reliance on "one skilled in the art" for anticipation appears to be a misguided analogy to obviousness type rejections. As is well known, the correct standard for anticipation is that "[a] claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently

described, in a single prior art reference." Verdegaal Bros. v. Union Oil Co. of California, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Thus, an express anticipation analysis is based on what is expressly described in a prior art reference and not what "one skilled in the art" would "anticipate" or what would be "clearly understood".[1]

Regarding the substance of the rejection, the Examiner's rejection is solely based on two passages in US 5,243,226 ("Chan"). The two passages are "[c]urrent I2 reduces the antifuse resistance even if |I2| (the magnitude of I2) is not higher than I1." (col. 3, lines 65-66) and "[t]he second pulse 210.2 reduces the antifuse resistance more consistently if current I2 is lower in magnitude that current I1" (col. 4, lines 8-10). The Examiner and the Appellant differ on the correct interpretation of these passages.

The Examiner interprets these two passages as expressly teaching that the current I2 may be higher than the current I1. See, Examiner's Answer page 5, 1st full paragraph. While Chan provides detailed disclosure of using a current I2 that is less than the current I1, the Examiner stated that he considers this a "preferred embodiment". The Examiner contends, however, that the two above-quoted passages disclose another embodiment in which the current I2 is greater than I1. See, e.g., page 5, last paragraph.

Appellant disagrees. The Examiner's contentions are based on an incorrect interpretation of these passages. The Examiner is reading these passages as statements of alternative embodiments. See, page 5, last paragraph. Appellant contends that Chan is not providing alternative embodiments in these passages, but is simply a comparison of the disclosed invention with what would be expected under the conventional wisdom. In other words, Chan is stating that the invention of using a current I2 that is less than

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[1] Appellant notes that the term "persons of ordinary skill" is used for inherent anticipation, as stated in In re Robertson, 169 F.3d 743, 49 USPQ2d 1949 (Fed. Cir. 1999), "to establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill.'" (Quoting Continental Can Co. v. Monsanto Co., 948 F.2d 1264, 1268, 20 U.S.P.Q.2d 1746, 1749 (Fed. Cir. 1991)). As the Examiner repeatedly states in the Examiner's Answer, however, his rejection is based on express anticipation. See, e.g., page 5, first full paragraph; page 6, third paragraph; inter alia.

current I1 reduces antifuse resistance despite the conventional wisdom that one must increase the current to reduce resistance.

Appellant's interpretation of these passages is supported by the discussion through Chan. For example, Chan states "[r]educing |I2| runs against the general rule that a greater current through the antifuse provides lower resistance." Col. 4, lines 14-16. Similarly, Chan states "This discovery runs against the conventional wisdom that a higher programming current always provides a lower resistance." Col. 2, lines 36-38. Moreover, at col. 1, lines 55-61, in the "Background of the Invention" section, Chan states

> It was confirmed experimentally that a higher programming current does provide a lower resistance. However, the current in a programmable circuit cannot be increased indefinitely because high current can damage circuit devices. Thus, it is desirable to find a programming method that provides a low antifuse resistance while using a low programming current.

Thus, consistent with Appellant's interpretation, it follows that Chan's statement regarding the antifuse resistance is reduced even if the magnitude of the current is not increased is simply a statement that the invention works even though it is contrary to the "general rule".

On the other hand, the Examiner's interpretation that the passages in Chan disclose an alternative embodiment is based on inferences and assumptions that are inconsistent with the full disclosure of Chan. For example, Chan does not refer to alternative embodiments in these passages. In fact, in the section entitled "Summary of the Invention" Chan states "[t]his invention allows one to program an antifuse so as to 5 [sic] lower the antifuse resistance without increasing the programming current." Col. 2, lines 18-21. Thus, it is clear that Chan did not contemplate an embodiment in which I2 is increased to be greater than I1 as suggested by the Examiner.

Moreover, as noted by the Examiner, these passages are "provided in a negative sense". Page 4, last paragraph and page 5, first paragraph. It would defy reason that Chan would list alternative embodiments of his invention "in a negative sense". Further,

Chan did not claim the embodiment that is suggested by the Examiner. Chan, however, did specifically claim an embodiment in which I2 is equal to I1 and in which I2 is less than I1. See, e.g. Claims 4-7.

In addition, as can be seen in the attached Declaration Pursuant to 37 C.F.R. §1.132 (the "Declaration"), the inventor listed on the Chan reference, Andrew K. Chan, himself does not agree with the Examiner's interpretation. The Declaration was not submitted earlier because the Examiner had never made clear that his interpretation of 35 U.S.C. §102 is based on "[i]f what a reference is teaching, as clearly understood by one skilled in the art, directly corresponds to the claim language, the requirement is met." Thus, it is submitted that the present Declaration is submitted in a timely fashion, e.g., under 37 C.F.R. §1.195, in order to rebut the Examiner's assumption of what "one skilled in the art" would clearly understand. As noted in the Declaration, the Inventor himself does not agree with or understand the Examiner's assumption.[2]

Accordingly, Appellant contends that the Examiner's interpretation that these passages provide an alternative embodiment in which I2 is greater than I1 is an incorrect and unsupported interpretation.

Moreover, Appellant submits that the Examiner is not only incorrectly interpreting these passages as alternative embodiments, but that these passages do not "expressly" disclose what the Examiner contends.

The Examiner's only support for his conclusion that Chan discloses the use of a current I2 that is greater than I1 is based on the argument that "the contrary of I2 being lower than I1 is when I2 is not lower than I1" and that "[t]his would necessarily include the situation wherein I2 and I1 are equal and wherein I2 is greater than I1." Page 7, first full paragraph. Thus, the Examiner is drawing an inference from the passages. The Examiner's conclusions are based on what the Examiner believes these passages imply,

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[2] The Appellant disagrees with the Examiner's underlying premise that express anticipation may be found based on what one skilled in the art would understand to be disclosed in the reference as opposed to what is explicitly stated in the reference. Nevertheless, the Declaration is presented to refute the Examiner's assumption of what one skilled in the art would understand, should the Board of Patent Appeals and Interferences adopt the Examiner's interpretation of 35 U.S.C. §102.

not what these passages expressly state.[3] Accordingly, Appellant contends that each and every element as set forth in the claim is not expressly found in a single prior art reference and, thus, Chan does not anticipate the claims.

Moreover, Appellant contends that the Examiner's underlying premise for his argument supporting his interpretation is incorrect. The Examiner's underlying premise is that Chan is disclosing an embodiment in which "the contrary of I2 being lower than I1 is when I2 is not lower than I1 (see Col. 2 [sic, 3], line 65 of Chan)." What Chan actually states, however, is that "[c]urrent I2 reduces the antifuse resistance even if |I2| (the magnitude of I2) is not higher than I1." This is not a statement that one embodiment of the Chan's invention is "the contrary of I2 being lower than I1". As discussed above, Chan is stating that his invention of using a current I2 that is equal to or less than a current I1 reduces antifuse resistance despite the conventional wisdom that increasing current provides lower resistance.

In addition, Appellant's note that the Examiner's Answer does not include a comparison of the cited reference to the claims themselves. Claim 1, for example, recites "passing a first pulse through said material ... said first pulse is a current limited pulse" and "wherein the current in said current limited pulse is lower in magnitude than the current in said second pulse". While the Examiner goes to great lengths to read into Chan an embodiment in which the second current I2 is greater than the first current I1, the Examiner has not shown where Chan discloses using a first pulse that is a "current limited pulse" that is "lower in magnitude than the current in said second pulse."

Accordingly, Appellant contends that the passages cited by the Examiner do not "expressly" disclose what is claimed.

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[3] The Examiner basis his argument that Chan "expressly" discloses that I2 can be greater than I1 on the proposition that the "plain meaning of the term 'expressly' would be 'clearly stated'" and not "explicitly." Page 6, third paragraph. The Examiner does not support his proposed definition of "expressly" nor are Appellants aware of such support. Moreover, according to the Merriam-Webster's Collegiate Dictionary 10th Edition, the definition of "expressly" is "explicitly" (a copy of which is attached hereto as Exhibit A). Nevertheless, even if the Examiner's definition of "expressly" were used, Appellants submit that the Examiner's interpretation is not "clearly stated" as it must be inferred from the passage.

Moreover, while the Examiner clearly states in the Examiner's Answer that his rejection is based on "express" anticipation, as discussed in Appellant's Appeal Brief, for the sake of completeness, Appellant contends there is no "inherent" anticipation either.

Appellant discusses inherent anticipation in the Appeal Brief, which the Examiner dismissed under the mistaken belief that Appellant was discussing case law relating to 35 U.S.C. §112, sixth paragraph. Page 6, last paragraph and page 7 first paragraph. While dismissed by the Examiner, Appellant stands by the discussion and analysis of the relevant case law regarding inherent anticipation. For the record, the expanded quotation from In re Robertson, 169 F.3d 743, 49 USPQ2d 1949 (Fed. Cir. 1999), is

> If the prior art reference does not expressly set forth a particular element of the claim, that reference still may anticipate if that element is "inherent" in its disclosure. To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. (Emphasis added)

Regarding the analysis of probabilities and possibilities discussion in Appellant's Appeal Brief, the Examiner stated "[t]he reference to Chan does not discuss what 'may result', it states what will result. Chan expressly states that the antifuse will program when I2 is greater than I1, but with less consistency." Page 7, first paragraph. Appellant assert that the Examiner is misquoting the relevant passage, which states "The second pulse 210.2 reduces the antifuse resistance more consistently if current I2 is lower in magnitude that current I1." Col. 4, lines 8-10. As can be seen, the passage does not expressly state that "I2 is greater than I1".

Appellant contends that this passage may be interpreted that the antifuse will program when I2 is equal to I1, but with less consistency. In fact, Appellant contends that such an interpretation of this passage is as correct, if not more correct, than the Examiner's interpretation. As discussed in the Appeal Brief, the interpretation that this passage implies I2 is equal to I1 is consistent with the disclosure throughout Chan. By way of example, Chan states "It was confirmed experimentally that a higher programming current does provide a lower resistance. However, the current in a programmable circuit cannot

be increased indefinitely because high current can damage circuit devices." Col. 1, lines 55-59. Thus, ideally, the maximum permissible current would be used for both I1 and I2. Further, as discussed above, Chan states "[t]his invention allows one to program an antifuse so as to 5 [sic] lower the antifuse resistance without increasing the programming current." Col. 2, lines 18-21. Thus, an interpretation of this passage that I2 is increased to be greater than I1 as suggested by the Examiner, is contrary to what Chan states is his invention.

With regard to the Appellant's contention that the passage may be interpreted as the antifuse will program when I2 is equal to I1, but with less consistency, the Examiner states "it is not seen how such a conclusion can be made without conjuncture." Page 7, first full paragraph. The Examiner's statement applies equally to the Examiner's conclusion that "the antifuse will program when I2 is greater than I1, but with less consistency." Thus, according to the Examiner's own reasoning, the Examiner's conclusion is merely a possibility, albeit in Appellant's view a lower probability than the Appellant's conclusion. As discussed in the Appeal Brief, "[i]nherency, however may not be established by probabilities or possibilities." In re Robertson, 169 F.3d 743, 49 USPQ2d 1949 (Fed. Cir. 1999). Accordingly, Appellant submits that Chan does not inherently anticipate the claims.

Accordingly, Chan does not expressly or inherently disclose all the elements of Claim 1. Claim 1 is not anticipated by Chan. Thus, the group consisting of Claims 1, 3, 5-10, 12-18, 22, and 24-25 which stand and fall together are all allowable.

For the above reasons, Appellant respectfully requests reversal of the rejection of Claims 1-3, 5, 6, 9-17, and 21-23. Should there by any questions concerning this Reply Brief, Appellant's attorney may be reached at (408) 982-8202.

Via Express Mail Label No.
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Respectfully submitted,

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Appendix

The following claims are involved in this appeal:

1. A method of programming an antifuse, said antifuse comprising a material that is substantially non-conductive when said antifuse is unprogrammed, said material being disposed between and in electrical contact with a first conductive element and a second conductive element, said method comprising:

passing a first pulse through said material so as to drive material from said first conductive element into said material as a conductive filament, said first pulse is a current limited pulse; and

passing a second pulse through said material in the opposite direction of said current limited pulse so as to drive material from said second conductive element into said material thereby increasing the cross sectional area of said conductive filament and reducing the resistance of said antifuse;

wherein the current in said current limited pulse is lower in magnitude than the current in said second pulse, and wherein said current limited pulse is passed through said material prior to any other pulse.

2. The method of Claim 1, wherein said current limited pulse and said second pulse have approximately the same voltage with opposite polarity.

3. The method of Claim 1, wherein said current in said current limited pulse is 20 to 33 percent lower in magnitude than said current in said second pulse.

5. The method of Claim 1,

wherein passing said current limited pulse through said material comprises applying a first voltage to said first conductive element and applying a second voltage to said second conductive element, said second voltage being greater in magnitude than said first voltage, and limiting the current to a desired magnitude; and

wherein passing said second pulse through said material comprises applying said second voltage to said first conductive element and applying said first voltage to said second conductive element.

6. The method of Claim 1, wherein said material comprises amorphous silicon and said conductive filament comprises silicide.

9. A method of programming an antifuse, said antifuse comprising a material that is substantially non-conductive when said antifuse is unprogrammed, said material being disposed between and in electrical contact with a first conductive element and a second conductive element, said method comprising:

applying a prepulse to said material, said prepulse having a current of a first magnitude that drives material from said first conductive element into said material as a conductive filament; and

applying a programming pulse to said material, said programming pulse having a current of a second magnitude that drives material from said second conductive element into said material adding to said conductive filament;

wherein said current of said first magnitude is lower than said current of said second magnitude, and wherein said prepulse is applied prior to applying any programming pulses.

10. The method of Claim 9, wherein said current of said second magnitude is 20 to 33 percent greater in magnitude than said current of said first magnitude.

11. The method of Claim 9,

wherein said prepulse has a first voltage applied to said first conductive element and a second voltage applied to said second conductive element; and

wherein said first programming pulse has said second voltage applied to said first conductive element and said first voltage applied to said second conductive element.

12. The method of Claim 9, wherein said current of said programming pulse is applied in the opposite direction of said current of said prepulse.

13. The method of Claim 12, further comprising applying a second programming pulse to said material, said second programming pulse having a current of a third magnitude, said current of said second programming pulse being applied in the same direction of said current of said prepulse.

14. The method of Claim 13, wherein said third magnitude is not greater than said second magnitude.

15. The method of Claim 13, wherein said third magnitude is greater than said second magnitude.

16. The method of Claim 13, further comprising repeatedly applying said first programming pulse and said second programming pulse a predetermined number of times.

17. The method of Claim 13, further comprising repeatedly applying said first programming pulse and said second programming pulse until the resistance of said antifuse is below a predetermined value.

21. A method of programming an antifuse, said antifuse comprising a material that is substantially non-conductive when said antifuse is unprogrammed, said method comprising:

applying a first voltage across said material and a first current through said material, said first current driving a conductive filament with a first cross sectional area through said material; and

applying a second voltage across said material and a second current through said material, said second voltage having the same magnitude and opposite polarity as said first voltage, said second current having a greater

magnitude and opposite polarity as said first current, said second current increasing the size of said conductive filament to a second cross sectional area, said second cross sectional area being greater than said first cross sectional area;

wherein said first current having insufficient magnitude to produce a conductive filament with said second cross sectional area, and wherein said first current is applied through said material prior to any current which has sufficient magnitude to produce a conductive filament with said second cross sectional area.

22. A method of programming an antifuse, said antifuse comprising a material that is substantially non-conductive when said antifuse is unprogrammed, said method comprising:

applying at least one prepulse to said material, said prepulse including a first current to drive a conductive filament through said material, said first current having insufficient magnitude to produce said conductive filament with a desired resistance; and

applying at least one programming pulse to said material after the application of said at least one prepulse, said programming pulse including a second current having a greater magnitude than said first current to increase the cross sectional area of said conductive filament and to decrease the resistance of said conductive filament to a desired resistance,

wherein said prepulse is applied prior to the application of any programming pulses.

23. The method of Claim 22, wherein said prepulse and said programming pulse have the same magnitude voltages with opposite polarities.